Add A1

What is claimed is:

1. A liquid crystal display device comprising: a first substrate and a second substrate processed for vertical alignment; and a liquid crystal having a negative dielectric constant anisotropy and being sandwiched between said first and second substrates; orientations of said liquid crystal being vertical to said first and second substrates when no voltage being applied, being almost horizontal to said first and second substrates when a predetermined voltage being applied and being oblique to said first and second substrates when an intermediate voltage lower than the predetermined voltage being applied,

said first substrate comprising first domain regulating means for regulating azimuths of the oblique orientations of said liquid crystal;

said first domain regulating means comprising a first structure for partially changing a contact surface between said first substrate and said liquid crystal to inclined surfaces;

wherein the liquid crystal in the proximity of said inclined surfaces being vertically oriented to said inclined surfaces when no voltage being applied, and azimuths of said liquid crystal far from said inclined surface being determined according to the azimuths of said liquid crystal in the proximity of said inclined surface when said intermediate voltage being applied.

2. A liquid crystal display device according to claim 1, wherein said first structure includes protrusions projected to a layer of said liquid crystal.

3. A liquid crystal display device according to claim 2, wherein said protrusions are made of dielectric materials on a first electrode of said first substrate.

4. A liquid crystal display device according to claim 2, wherein pixel electrodes are formed on said second substrate, each of said protrusions extends

straightly, and said protrusions are arranged in parallel to one another with a predetermined pitch among them.

5. A liquid crystal display device according to claim 4, wherein said predetermined pitch is equal to an arrangement pitch of said pixel electrodes, said protrusions extend in parallel to edges of said pixel electrodes and pass on positions facing to centers of said pixel electrodes.

6. A liquid crystal display device according to claim 2, wherein pixel electrodes are formed on said second substrate, said protrusions have point-like figures and said protrusions are arranged at positions facing to centers of said pixel electrodes.

7. A liquid crystal display device according to claim 1, wherein said first structure includes depressions depressed from a layer of said liquid crystal.

8. A liquid crystal display device according to claim 7, wherein said depressions are provided under a first electrode of said first substrate, and a surface of said first electrode partially has inclined surfaces corresponding to said depressions.

9. A liquid crystal display device according to claim 7, wherein a first electrode of said first substrate includes slits operating as domain regulating means, said depressions and said slits are mutually arranged.

10. A liquid crystal display device according to claim 1, wherein said first structure includes protrusions projected to a layer of said liquid crystal and depressions depressed from said layer of said liquid crystal.

11. A liquid crystal display device according to claim 11, wherein said protrusions and said depressions are mutually arranged in parallel with a predetermined pitch.

12. A liquid crystal display device according to

claim 1, wherein area of said inclined surfaces in each pixel is less than 50% of area of the pixel.

13. A liquid crystal display device according to claim 1, wherein said second substrate comprising second domain regulating means for regulating azimuths of the oblique orientations of said liquid crystal;

14. A liquid crystal display device according to claim 13, wherein said second domain regulating means comprises a second structure for partially changing a contact surface between said second substrate and said liquid crystal to inclined surfaces, and said first and second structures include protrusions projected to a layer of said liquid crystal.

15. A liquid crystal display device according to claim 13, wherein said second domain regulating means comprises a second structure for partially changing a contact surface between said second substrate and said liquid crystal to inclined surfaces, and said first and second structures include depressions depressed from a layer of said liquid crystal.

16. A liquid crystal display device according to claim 13, wherein said second domain regulating means comprises a second structure for partially changing a contact surface between said second substrate and said liquid crystal to inclined surfaces, one of said first and second structures includes protrusions projected to a layer of said liquid crystal, and the other includes depressions depressed from a layer of said liquid crystal.

17. A liquid crystal display device according to claim 13, wherein said second domain regulating means is slits provided on a second electrode of said second substrate, and said first structure includes protrusions projected to a layer of said liquid crystal.

18. A liquid crystal display device according to claim 13, wherein said second domain regulating means is slits provided on a second electrode of said second

substrate, and said first structure includes depressions depressed from a layer of said liquid crystal.

19. A liquid crystal display device according to claim 13, wherein said second domain regulating means comprises a second structure for partially changing a contact surface between said second substrate and said liquid crystal to inclined surfaces, and said first and second structures respectively include a pair of protrusions and depressions depressed from a layer of said liquid crystal.

20. A liquid crystal display device according to claim 19, wherein said protrusions and depressions on each substrate are mutually arranged in parallel with pitches of one and three, said protrusions and depressions of said first and second substrates are arranged in parallel to each other and are arranged so that said protrusions and depressions face wide spaces corresponding to large pitch, and protrusions and depressions of different substrates respectively neighbor.

21. A liquid crystal display device according to claim 13, wherein said first structure includes depressions depressed from a layer of said liquid crystal, a first electrode of said first substrate includes slits, said second domain regulating means comprises a second structure including depressions depressed from a layer of said liquid crystal and slits provided on a second electrode of said second substrate.

22. A liquid crystal display device according to claim 21, wherein said depressions and slits on each substrate are mutually arranged in parallel with pitches of one and three, said depressions and slits of said first and second substrates are arranged in parallel to each other and are arranged so that said depressions and slits face wide spaces corresponding to large pitch, and protrusions and depressions of different substrates respectively neighbor.

23. A liquid crystal display device according to claim 13, wherein said second domain regulating means comprises a second structure provided on said second substrate for partially changing a contact surface between said second substrate and said liquid crystal to inclined surfaces.

24. A liquid crystal display device according to claim 23, wherein said first and second structures are made of dilerectric materials on electrodes of said first and second substrates.

25. A liquid crystal display device according to claim 23, wherein said first and second structures are made of conductive materials on electrodes of said first and second substrates.

26. A liquid crystal display device according to claim 23, wherein said first and second structures are provided under electrodes of said first and second substrates, and surfaces of said electrodes partially have inclined surfaces corresponding to said first and second structures.

27. A liquid crystal display device according to claim 23, wherein said first and second structures are arranged perimetric portions outside of display area in which no pixel exists.

28. A liquid crystal display device according to claim 24, wherein said dielectric material forming said first and second structures is photosensitive resist.

29. A liquid crystal display device according to claim 28, wherein said photosensitive resist is a novolak resist.

30. A liquid crystal display device according to claim 28, wherein said photosensitive resist is baked after a pattern is drawn.

31. A liquid crystal display device according to claim 24, wherein the capacitance of said first and second structures is ten or less times larger than the capacitance of a layer of said liquid crystal located

under or near said protrusions.

32. A liquid crystal display device according to claim 24, wherein the specific resistance of said first and second structures is equal or larger than the specific resistance of said liquid crystal.

33. A liquid crystal display device according to claim 24, wherein said first and second structures include protrusions projected to a layer of said liquid crystal, and said protrusions are made of material shielding visible light.

34. A liquid crystal display device according to claim 24, wherein said first and second structures include protrusions projected to a layer of said liquid crystal, and said protrusions are provided with dents each having a slope in a longitudinal direction.

35. A liquid crystal display device according to claim 24, wherein said first and second structures include protrusions projected to a layer of said liquid crystal, and juts each partly having a slope in a longitudinal direction are formed on said protrusions.

36. A liquid crystal display device according to claim 24, wherein said first and second structures include protrusions projected to a layer of said liquid crystal, and center portions of said protrusions are depressed.

37. A liquid crystal display device according to claim 24, wherein said first and second structures include protrusions projected to a layer of said liquid crystal, and said protrusions include a plurality of small holes extending near to the surface of said electrodes.

38. A liquid crystal display device according to claim 24, wherein said first and second structures include ion absorption ability.

39. A liquid crystal display device according to claim 38, wherein said first and second structures are made of materials added with addition agent having ion

absorption abilities.

40. A liquid crystal display device according to claim 24, wherein said first and second structures include protrusions projected to a layer of said liquid crystal, and the surfaces of said protrusions is treated so as to be adapted for forming vertical alignment films thereon.

~~40~~ 41. A liquid crystal display device according to claim 24, wherein said first and second structures include protrusions projected to a layer of said liquid crystal, and the surfaces of said protrusions is treated to facilitate the formation of vertical alignment films.

~~41~~ 42. A liquid crystal display device according to claim ~~40~~ 41, wherein said surface treatment to the surfaces of said protrusions is effected for forming ruggedness.

~~42~~ 43. A liquid crystal display device according to claim ~~40~~ 41, wherein said protrusions are made of resist, and said surface treatment to the surfaces of said protrusions is effected for irradiating with ultraviolet rays to the surfaces of said protrusions.

~~43~~ 44. A liquid crystal display device according to claim ~~40~~ 41, wherein said protrusions are made of materials in which particulates are dispersed.

~~44~~ 45. A liquid crystal display device according to claim ~~40~~ 41, wherein silane coupling agent is coated on the surfaces of said protrusions.

~~45~~ 46. A liquid crystal display device according to claim 24, wherein said first and second structures are formed by printing.

~~46~~ 47. A liquid crystal display device according to claim 24, wherein said first and second structures includes protrusions projected to a layer of said liquid crystal, a diameter of spherical spacers difining a thickness of said layer of sa liquid crystal is a difference subtracted a height of said protrusions from a desirable thickness of said liquid crystal layer.

~~47~~ 48. A liquid crystal display device according to

claim 17, wherein a ratio of area of said protrusions with respect to display area is between 1/10 to 1/2, said spacers have a particle size distribution whose standard deviation is 0.1 to 0.3 micrometers, and said spacers are dispersed with a density of 300 particles per square millimeter.

19. A liquid crystal display device according to claim 17, wherein hardness and elastic modulus of the material forming said protrusions are larger than those of said spacers.

50. A liquid crystal display device according to claim 24, wherein said first and second structures includes at least one layer simultaneously formed with other portions of the device.

51. A liquid crystal display device according to claim 50, wherein one of said first and second structures, which is on a TFT substrate on which active elements are formed, includes at least one insulating layer for insulating said active elements or bus lines.

52. A liquid crystal display device according to claim 50, wherein one of said first and second structures, which is on a color filter (CF) substrate facing a TFT substrate on which active elements are formed, includes protrusions projected to a layer of said liquid crystal, and said protrusions on said CF substrate is made of materials same as materials of black matrices for shielding light at boundaries between pixel electrodes and bus lines or portions of active elements.

53. A liquid crystal display device according to claim 52, wherein one of said first and second structures, which is on a color filter (CF) substrate facing a TFT substrate on which active elements are formed, includes protrusions projected to a layer of said liquid crystal, and said protrusions on said CF substrate are formed by piling at least one material of color filters.

54. A liquid crystal display device according to

claim 51, wherein one of said first and second structures, which is on a color filter (CF) substrate facing a TFT substrate on which active elements are formed, includes protrusions projected to a layer of said liquid crystal, said protrusions on said CF substrate are formed by photo lithography with a mask corresponding to piled portions of at least two color filters.

54. A liquid crystal display device according to claim 51, wherein one of said first and second structures, which is on a color filter (CF) substrate facing a TFT substrate on which active elements are formed, includes protrusions projected to a layer of said liquid crystal, an electrode of said CF substrate is formed on color filters, and said protrusions on said CF substrate are formed at boundaries of said color filters.

55. A liquid crystal display device according to claim 23, wherein a part of said first and second structures are arranged at a perimeter of each pixel.

56. A liquid crystal display device according to claim 55, wherein said first and second structures arranged at a perimeter of each pixel are made of material shielding light.

57. A liquid crystal display device according to claim 55, wherein said first and second structures arranged at a perimeter of each pixel define a thickness of a layer of said liquid crystal.

58. A liquid crystal display device according to claim 55, wherein the perimeter at which said first and second structures are arranged is a part of whole perimeter of each pixel.

59. A liquid crystal display device according to claim 23, wherein at least one of said first and second structures includes protrusions projected to a layer of said liquid crystal, height of said protrusions is equal to a desirable thickness of a layer of said liquid crystal.

60. A liquid crystal display device according to

claim 23, wherein said first and second structures includes protrusions projected to a layer of said liquid crystal, a sum of height of said protrusions of said first and height of said protrusions of said second structures is equal to a desirable thickness of a layer of said liquid crystal.

~~61~~ 62. A liquid crystal display device according to claim 13, wherein said second domain regulating means includes slits provided on a second electrode of said second substrate.

~~62~~ 63. A liquid crystal display device according to claim ~~61~~ 62, wherein said second electrode consists of pixel electrodes, and each pixel electrode comprises partial electrodes divided by said slits and electrical connection portions electrically connecting said partial electrodes.

~~63~~ 64. A liquid crystal display device according to claim ~~62~~ 63, wherein said electrical connection portions are arranged at perimeter of said pixel electrode.

~~64~~ 65. A liquid crystal display device according to claim ~~62~~ 63, comprising light shield means for shielding a part of said electrical connection portions.

~~65~~ 66. A liquid crystal display device according to claim ~~62~~ 63, wherein said second domain regulating means includes protrusions higher than surfaces of said pixel electrodes and arranged inside said slits.

~~66~~ 67. A liquid crystal display device according to claim 13, wherein said first structure is an array of protrusions (banks) or depressions (grooves) each extending straightly, said protrusions or depressions are arranged in parallel to one another with a predetermined pitch among them, second domain regulating means includes an array of protrusions or depressions or slits each extending straightly, said protrusions, depressions or slits are arranged in parallel to one another with said predetermined pitch among them, said predetermined pitch is less than an arrangement pitch of said pixel electrodes.

68
67. A liquid crystal display device according to claim 13, wherein said first structure is a pair of arrays of protrusions (banks) or depressions (grooves) each extending straightly, said protrusions or depressions are arranged in parallel to one another with a predetermined pitch among them, second domain regulating means includes a pair of arrays of protrusions or depressions or slits each extending straightly, said protrusions, depressions or slits are arranged in parallel to one another with a predetermined pitch among them, directions in which said protrusions or depressions or slits of said pairs extend are different to each other, and said predetermined pitches are less than an arrangement pitch of said pixels.

69 68
68. A liquid crystal display device according to claim 67, wherein said directions in which said protrusions or depressions or slits of said pairs extend are mutually different by 90 degrees.

70 68
69. A liquid crystal display device according to claim 67, wherein said first structure includes protrusions, said second domain regulating means includes protrusions or slits, protrusions or slits of one of said pairs are mutually offset by a half of said predetermined pitch, protrusions or slits of the other of said pairs are a little offset from a state in which said protrusions or slits face.

71 67
70. A liquid crystal display device according to claim 66, wherein said predetermined pitch is an integral submultiple of arrangement pitch of said pixels.

72
71. A liquid crystal display device according to claim 13, wherein said first structure is an array of protrusions (banks) or depressions (grooves) each extending in one direction and being bent in zigzag at intervals of a predetermined cycle, said protrusions or depressions are arranged in parallel to one another with a predetermined pitch among them, second domain regulating means includes an array of protrusions or

depressions or slits each extending in one direction and being bent in zigzag at intervals of said predetermined cycle, said protrusions, depressions or slits are arranged in parallel to one another with said predetermined pitch among them.

73 72. A liquid crystal display device according to claim 71, wherein pixel electrodes are bent in zigzag, and patterns of said protrusions, depressions or slits correspond to said pixel electrodes.

74 72. A liquid crystal display device according to claim 71, wherein bus lines are partially bent in zigzag and in correspondence to the patterns of said pixel electrodes.

75 72. A liquid crystal display device according to claim 71, wherein a pattern of each pixel electrode is almost a square, and pixel electrodes in adjoining row are mutually offset by a half of arrangement pitch of said pixel electrodes.

76 75. A liquid crystal display device according to claim 74, wherein data bus lines extend in zigzag along with edges of said pixel electrodes.

77 72. A liquid crystal display device according to claim 71, wherein said predetermined pitch is an integral submultiple of said pixels.

78 77. A liquid crystal display device according to claim 76, wherein said predetermined cycle is an integral submultiple of said pixels.

79 67. A liquid crystal display device according to claim 68, wherein said first structure includes protrusions, said second domain regulating means includes protrusions or slits, said protrusions of said first structure and said protrusions or slits of said second domain regulating means are offset by a half of said predetermined pitch.

80 67. A liquid crystal display device according to claim 66, wherein said first structure includes protrusions, said second domain regulating means includes

protrusions or slits, said protrusions of said first structure and said protrusions or slits of said second domain regulating means are offset from a state in which said protrusions or slits face, and said offset is fully smaller than said predetermined pitch.

81. A liquid crystal display device according to claim 67, wherein said first structure includes depressions, said second domain regulating means includes depressions, said depressions of said first structure and said depressions of said second domain regulating means are offset by a half of said predetermined pitch.

82. A liquid crystal display device according to claim 67, wherein said first structure includes depressions, said second domain regulating means includes protrusions or slits, said depressions of said first structure and said protrusions or slits of said second domain regulating means are arranged to face to each other.

83. A liquid crystal display device according to claim 1, wherein said first structure includes protrusions, a liquid crystal injection port through which said liquid crystal in injected into a gap between said first and second substrates is located on a side of said device vertical to a direction in which said protrusions are extending.

84. A liquid crystal display device according to claim 83, wherein exhaust ports through which an air or liquid crystal is exhausted from the gap when said liquid crystal is injected are located on a side opposite to the side on which said liquid crystal injection port is located.

85. A liquid crystal display device according to claim 83, wherein an electrode used to apply a voltage to said liquid crystal and having no relation to display is formed near said liquid crystal injection port.

86. A liquid crystal display device according to claim 23, wherein said first structure includes

protrusions formed with a two-dimensional lattice, said second structure include point-like protrusions respectively facing centers of each frame element of said two-dimensional lattice.

87. A liquid crystal display device according to claim 86, wherein at least one of arrangement pitches of said two-dimensional lattice is smaller than one of arrangement pitches of pixel electrodes.

88. A liquid crystal display device according to claim 86, wherein arrangement pitches of said two-dimensional lattice coincide with arrangement pitches of pixel electrodes.

89. A liquid crystal display device according to claim 87, wherein said protrusions having said two-dimensional lattice form are arranged on boundaries of pixel electrode on a TFT substrate on which active elements are formed, and said point-like protrusions are arranged on a color filter substrate facing said TFT substrate so that each point-like protrusion faces to a center of each pixel electrode.

90. A liquid crystal display device according to claim 23, wherein said first and second structures includes a plurality of groups each having protrusions extending along edges of rectangulars of similar figures and of different sizes, and said protrusions are mutually arranged so that centers of respective rectangulars coincide to each other.

91. A liquid crystal display device according to claim 90, wherein said rectangulars are similar to said pixels, a maximum size of said rectangular coincides with that of each pixel, and centers of said rectangulars of each group coincide with a center of each pixel.

92. A liquid crystal display device according to claim 13, comprising auxiliary domain regulating means arranged perimeters of each pixel for generating orientation regulation force in a direction different from the direction of orientation regulation force by the

electric field generated in a non-display region.

93 92. A liquid crystal display device according to claim 91, wherein said auxiliary domain regulating means is arranged along a part and in the neighborhood of an edge of said pixel.

94 93. A liquid crystal display device according to claim 23, wherein said first and second domain regulating means are protrusions projected to a layer of said liquid crystal, pixel electrodes are provided on said first substrate, a counter electrode is provided on said second electrode, and at the edges of each pixel electrode extending in parallel to the extending direction of said protrusions, the protrusions nearest to the pixel electrode inside said pixel electrode are located on said second substrate, and the protrusions nearest to the pixel electrode outside said pixel electrode are located on said first substrate.

95 94. A liquid crystal display device according to claim 93, wherein said protrusions nearest to said pixel electrode outside said pixel electrode are arranged on a bus line.

96 95. A liquid crystal display device according to claim 23, wherein said first and second domain regulating means are arrays of protrusions projected to a layer of said liquid crystal, and in said array of protrusions, at least one repetition condition of the array such as the width of the protrusions, the interval between adjacent protrusions and the height of the protrusions includes at least two different values.

97 96. A liquid crystal display device according to claim 95, wherein the interval between adjacent protrusions is smaller in the neighborhood of the bus line than at the central portion of the pixel.

98 97. A liquid crystal display device according to claim 96, wherein a plurality of pixels constitute a set of pixels, at least one of the width of the protrusions, the interval between adjacent protrusions and the height

of the protrusions is different among a plurality of pixels constituting each set of pixels, and the width of the protrusions, the interval between adjacent protrusions and the height of the protrusions are fixed in each pixel.

99. A liquid crystal display device according to claim 98, wherein the thickness of the layer of said liquid crystal is different at the plurality of pixels constituting the set.

100. A liquid crystal display device according to claim 23, wherein said first and second domain regulating means are arrays of protrusions projected to a layer of said liquid crystal, and said array of protrusions includes periodically-repeated protrusions having two or more different values of side surface inclination angles (taper angles).

101. A liquid crystal display device according to claim 100, wherein a plurality of pixels constitute a set of pixels, the side surface inclination angle of a protrusion is varied from one pixel to another in each pixel set, and the side surface inclination angle of the protrusion in each pixel is fixed.

102. A liquid crystal display device according to claim 13, comprising auxiliary electrodes (CS electrodes) for forming a storage capacitor with pixel electrodes, wherein said auxiliary electrodes are formed along of said domain regulating means.

103. A liquid crystal display device according to claim 13, comprising light shielding patterns provided along of said domain regulating means.

104. A liquid crystal display device according to claim 13, wherein said first structure is a first array of protrusions (banks) each extending straightly in a first direction, said protrusions are arranged in parallel to one another with a predetermined first pitch among them, said second domain regulating means includes a second array of protrusions or slits each extending

straightly in a second direction different from the first direction, said protrusions or slits are arranged in parallel to one another with a predetermined second pitch among them.

105
~~104~~. A liquid crystal display device according to claim 109
~~103~~, wherein additional protrusions or slits are further provided at centers of frames, which are formed when vertically seen to the substrates by said first array of protrusions and said second array of protrusions or slits, on either of said first or second substrate.

106
~~105~~. A liquid crystal display device according to claim 105
~~104~~, wherein said additional protrusions or slits have figures similar to the frames.

107
~~106~~. A liquid crystal display device according to claim 109
~~103~~, wherein said first array of protrusions and said second array of protrusions or slits are crossed at right angle when vertically seen to the substrates.

108
~~107~~. A liquid crystal display device according to claim 109
~~103~~, wherein a sum of a thicknesses of said protrusion of said first array and a thicknesses of said protrusion of said second array is equal to the thickness of a layer of said liquid crystal, and crossing portions of said protrusion of said first and second arrays operate as spacers.

109
~~108~~. A liquid crystal display device according to claim 13, wherein said first structure includes protrusions formed with a first two-dimensional lattice, said second domain regulating means includes protrusions or slits formed with a second two-dimensional lattice having same array pitches as those of said first two-dimensional lattice, and said first and second two-dimensional lattices are offset by half pitches of said array pitches.

110
~~109~~. A liquid crystal display device according to claim 109
~~108~~, wherein crossing portions, which are formed when vertically seen to the substrates by said first array of protrusions and said second array of protrusions

or slits, are mutually omitted, and said protrusions or slits of said first and second arrays are intermitten.

111
~~110~~. A liquid crystal display device according to claim 23, wherein said first and second structures include protrusions (banks) of dielectric materials each extending straightly in one direction, said protrusions are arranged in parallel to one another with a predetermined pitch among them, electrodes of said first and second substrates are partially formed on one of slopes of said protrusions.

112 111
~~111~~. A liquid crystal display device according to claim ~~110~~, wherein said dielectric materials forming said protrusions passes visual light.

113 111
~~112~~. A liquid crystal display device according to claim ~~110~~, wherein said protrusions of different substrates are arranged so that slopes of said protrusions on which no electrode is formed are nearer to each other.

119
~~113~~. A liquid crystal display device comprising: a first substrate and a second substrate processed for vertical alignment; and a liquid crystal having a negative anisotropic dielectric constant and being sandwiched between said first and second substrates; orientations of said liquid crystal layer being vertical to said first and second substrates when no voltage being applied, being almost horizontal to said first and second substrates when a predetermined voltage being applied and being oblique to said first and second substrates when an intermediate voltage lower than the predetermined voltage being applied,

said first and second substrates comprising first and second domain regulating means for regulating azimuths of the oblique orientations of said liquid crystal;

said first domain regulating means includes a first array of protrusions (walls) each extending straightly in a first direction, said

protrusions are arranged in parallel to one another with a predetermined first pitch among them;

said second domain regulating means includes a second array of protrusions or slits each extending straightly in a second direction different from the first direction, said protrusions or slits are arranged in parallel to one another with a predetermined second pitch among them.

115
~~114~~. A liquid crystal display device according to claim ~~113~~ 114, wherein additional protrusions or slits are further provided at centers of frames, which are formed when vertically seen to the substrates by said first array of protrusions and said second array of protrusions or slits, on either of said first or second substrate.

116
~~115~~. A liquid crystal display device according to claim ~~114~~ 115, wherein said additional protrusions or slits have figures similar to the frames.

117
~~116~~. A liquid crystal display device according to claim ~~113~~ 114, wherein said first array of protrusions and said second array of protrusions or slits are crossed at right angle when vertically seen to the substrates.

118
~~117~~. A liquid crystal display device comprising: a first substrate and a second substrate processed for vertical alignment; and a liquid crystal having a negative anisotropic dielectric constant and being sandwiched between said first and second substrates; orientations of said liquid crystal layer being vertical to said first and second substrates when no voltage being applied, being almost horizontal to said first and second substrates when a predetermined voltage being applied and being oblique to said first and second substrates when an intermediate voltage lower than the predetermined voltage being applied,

said first and second substrates comprising first and second domain regulating means for regulating azimuths of the oblique orientations of said liquid crystal;

said first domain regulating means includes an array of protrusions (banks) or depressions (grooves) or slits each extending in a direction and being bent in zigzag at intervals of a predetermined cycle, said protrusions or depressions are arranged in parallel to one another with a predetermined pitch among them;

second domain regulating means includes an array of protrusions or depressions or slits each extending in said direction and being bent in zigzag at intervals of said predetermined cycle, said protrusions, depressions or slits are arranged in parallel to one another with said predetermined pitch among them.

~~116~~ 119. A liquid crystal display device according to claim ~~117~~ 118, wherein said predetermined pitch is an integral submultiple of said pixels.

~~119~~ 120. A liquid crystal display device according to claim ~~117~~ 118, wherein said predetermined cycle is an integral submultiple of said pixels.

~~120~~ 121. A liquid crystal display device according to claim ~~117~~ 118, wherein said protrusions or depressions or slits of said first and secons substrates are offset by a half of said predetermined pitch.

~~121~~ 122. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which domain regulating means consisting of one of or a

~~recombination of~~ protrusions, depressions and slits formed in electrodes is provided on a surface of at least one of said two substrate and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that absorption axes thereof intersect with each other at right angles; and

at least one phase difference film having optically inplane positive uniaxiality, placed in at least one of spaces formed between said liquid crystal panel and one of said first and second polarizing plates, which are provided at one or both of the sides of said liquid crystal panel, and between said liquid crystal panel and the other thereof.

123
~~122~~. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical alignment to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which domain regulating means consisting of one of or a combination of protrusions, depressions and slits formed in electrodes is provided on a surface of at least one of said two substrate and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal

is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that absorption axes thereof intersect with each other at right angles; and

at least one of phase difference films each having optically negative uniaxiality in a direction of thickness thereof, placed in at least one of spaces formed between said liquid crystal panel and one of said first and second polarizing plates, which are provided at one or both of the sides of said liquid crystal panel, and between said liquid crystal panel and the other thereof.

~~123~~ 124. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which domain regulating means consisting of one of or a combination of protrusions, depressions and slits formed in electrodes is provided on a surface of at least one of said two substrate and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that

absorption axes thereof intersect with each other at right angles;

a first phase difference film having optically inplane positive uniaxiality, placed between said liquid crystal panel and said first polarizing plate so that a phase lag axis thereof intersects with the absorption axis of said first polarizing plate at right angles; and

a second phase difference film having optically negative uniaxiality in a direction of thickness thereof, placed between said liquid crystal panel and said second polarizing plate.

125
~~124~~. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical alignment to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which domain regulating means consisting of one of or a combination of protrusions, depressions and slits formed in electrodes is provided on a surface of at least one of said two substrate and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that absorption axes thereof intersect with each other at right angles;

a first phase difference film having optically inplane positive uniaxiality, placed between said liquid crystal panel and said first polarizing plate so that a phase lag axis thereof intersects with the absorption axis of said first polarizing plate at right angles; and

a second phase difference film having optically negative uniaxiality in a direction of thickness thereof, placed between said first phase difference film and said first polarizing plate.

126
125. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical alignment to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which domain regulating means consisting of one of or a combination of protrusions, depressions and slits formed in electrodes is provided on a surface of at least one of said two substrate and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that absorption axes thereof intersect with each other at right angles;

a first phase difference film having optically inplane positive uniaxiality, placed between

said liquid crystal panel and said first polarizing plate so that a phase lag axis thereof intersects with the absorption axis of said first polarizing plate at right angles; and

a second phase difference film having optically negative uniaxiality in a direction of thickness thereof, placed between said liquid crystal panel and said first polarizing plate.

~~126~~ 127. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical alignment to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which domain regulating means consisting of one of or a combination of protrusions, depressions and slits formed in electrodes is provided on a surface of at least one of said two substrate and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that absorption axes thereof intersect with each other at right angles;

at least one of phase difference films, whose inplane dielectric constantes n_x and n_y and dielectric constant n_z in a direction of thickness

thereof have the following relation: n_x, $n_y \geq n_z$, which is placed in at least one of spaces between said liquid crystal panel and one of said first and second polarizing plates and between said liquid crystal panel and the other thereof.

128
~~127~~. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical alignment to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that absorption axes thereof intersect with each other at right angles; and

at least one phase difference film having optically inplane positive uniaxiality, placed in at least one of spaces formed between said liquid crystal panel and one of said first and second polarizing plates, which are provided at one or both of the sides of said liquid crystal panel, and between said liquid crystal panel and the other thereof.

129
~~128~~. A liquid crystal display device, characterized by comprising:

a liquid crystal panel in which a liquid crystal having a negative dielectric constant anisotropy is sandwiched between two substrates, namely, upper and lower substrates on the surfaces of which a vertical alignment treatment is performed, and in which orientations of said liquid crystal are nearly vertical alignment to said substrates when no voltage is applied across said liquid crystal, and are nearly horizontal when a voltage is applied across said liquid crystal, and are nearly oblique when a voltage being less than a predetermined voltage is applied across said liquid crystal, and in which, when a voltage being less than the predetermined voltage is applied across said liquid crystal, said liquid crystal is regulated so that the oblique alignment is caused in a plurality of directions in each pixel;

first and second polarizing plates placed at both sides of said liquid crystal panel so that absorption axes thereof intersect with each other at right angles; and

at least one of phase difference films each having optically negative uniaxiality in a direction of thickness thereof, placed in at least one of spaces formed between said liquid crystal panel and one of said first and second polarizing plates, which are provided at one or both of the sides of said liquid crystal panel, and between said liquid crystal panel and the other thereof.

130
~~129~~. A liquid crystal display device in which negative-type liquid crystals are held between two pieces of upper and lower substrates of which the surfaces are vertically oriented, said liquid crystals are oriented nearly vertically when no voltage is applied, oriented nearly horizontally when a predetermined voltage is applied, and are oriented aslant when a voltage smaller than said predetermined voltage is applied, wherein one of said two pieces of color filter substrates comprises:

a transparent support member;

plural kinds of color decomposition filters formed on said transparent support member for each of the regions;

a transparent electrode formed on said color decomposition filters; and

a light-shielding film formed at any position on said transparent electrode.

131
~~130~~. A liquid crystal display device in which negative-type liquid crystal is held between an upper and lower substrates of which the surfaces are vertically oriented, said liquid crystal is oriented nearly vertically when no voltage is applied, oriented nearly horizontally when a predetermined voltage is applied, and are oriented aslant when a voltage smaller than said predetermined voltage is applied, wherein a molar mixing ratio of contamination elements of polyurethane and skin mixed to the liquid crystal is less than 1/1000.

132
~~131~~. A liquid crystal display device according to claim 131
~~130~~, wherein each contamination element of the mixed polyurethane or skin has an area smaller than 5 μm × by 5 μm.

133
~~132~~. A process for producing a substrate for vertically oriented liquid crystal display having, on the surface thereof, a protrusion that works as a domain regulating means to so restrict that said liquid crystals are oriented in a plurality of aslant direction in each pixel when a voltage smaller than a predetermined voltage is applied, comprising:

a step of forming a protrusion after electrodes have been formed on the surface of said substrate;

a step of treating the surface of said protrusion to facilitate the formation of a vertical alignment film; and

a step of forming a vertical alignment film on the surface of said substrate on which the

electrodes have been formed, of which the surface has been treated, and which includes said protrusion.

139
~~133~~. A process for producing a substrate for vertically oriented liquid crystal display according to claim 133, wherein ruggedness is formed on the surface of said protrusion by a plasma ashing treatment in the step of treating the surface of said protrusion.

135
~~134~~. A process for producing a substrate for vertically oriented liquid crystal display according to claim 133, wherein ruggedness is formed on the surface of said protrusion by an ozone ashing treatment in the step of treating the surface of said protrusion.

136
~~135~~. A process for producing a substrate for vertically oriented liquid crystal display according to claim 133, wherein ruggedness is formed on the surface of said protrusion by washing with a brush in the step of treating the surface of said protrusion.

137
~~136~~. A process for producing a substrate for vertically oriented liquid crystal display according to claim 133, wherein ruggedness is formed on the surface of said protrusion by rubbing in the step of treating the surface of said protrusion.

138
~~137~~. A process for producing a substrate for vertically oriented liquid crystal display according to claim 133, wherein said protrusion is irradiated with ultraviolet rays in the step of treating the surface of said protrusion.

139
~~138~~. A process for producing a substrate for vertically oriented liquid crystal display according to claim 133, wherein silane coupling agent is coated onto the substrate on which said protrusions are formed in the step of treating the surface of said protrusions.

140
~~139~~. A process for producing a substrate for vertically oriented liquid crystal display according to claim 133, wherein said protrusions are treated to foam in the step of treating the surface of said protrusions.

141
~~140~~. A process for producing a substrate for

vertically oriented liquid crystal display according to claim ~~139~~ 190, wherein said substrate is rapidly heating so that said protrusions foam in the step of treating the surface of said protrusions.

~~141~~ 192. A process for producing a substrate for vertically oriented liquid crystal display having, on the surface thereof, protrusions that work as domain regulating means to regulate azimuths of orientations of said liquid crystal when molecules of said liquid crystal are tilted by applying a voltage is applied, comprising:

a step of coating resin after electrodes are formed on the surface of the substrates;

a step of scattering particulates on the surface of the resin;

a step of forming the resin into protrusions; and

a step of forming a vertical alignment film on the surface of said substrate on which the electrodes and the protrusions have been formed.

~~142~~ 193. A process for producing a substrate for vertically oriented liquid crystal display having, on the surface thereof, walls that work as domain regulating means to regulate azimuths of orientations of said liquid crystal when molecules of said liquid crystal are tilted by applying a voltage is applied, comprising:

a step of forming sets of two walls neighboring to each other;

a step of heating said two walls to be fused into one wall having a groove at center thereof; and

a step of forming a vertical alignment film on the surface of said substrate on which the electrodes and the protrusions have been formed.

~~143~~ 194. A process for producing a color filter substrate that is used as one of the two pieces of substrates for a liquid crystal display device in which liquid crystals are oriented nearly vertically when no

voltage is applied, oriented nearly horizontally when a predetermined voltage is applied, and are oriented oblique when a voltage smaller than said predetermined voltage is applied, said color filter substrate having plural kinds of color decomposition filters formed on a transparent support member for each of the regions, comprising:

a step of successively forming two or more color decomposition filters while superposing predetermined portions one upon the other among said plural kinds of color decomposition filters;

a step of applying a positive-type photosensitive resin; and

a step of developing said negative-type photosensitive resist after said positive-type photosensitive resist is exposed, through said colored members, to light with which said positive-type photosensitive resist is photosensitized, said light having a wavelength that transmits very less through the portion where said two or more color decomposition filters are superposed than through other portions.

145. A process for producing a color filter substrate according to claim 143, further comprising a step of forming a transparent and flat layer after said plural kinds of color decomposition filters have been formed.

146. A process for producing a color filter substrate according to claim 143, wherein said positive-type photosensitive resist has light-shielding property.

147. A process for producing a color filter substrate that is used as one of the two pieces of substrates for a liquid crystal display device in which liquid crystals are oriented nearly vertically when no voltage is applied, oriented nearly horizontally when a predetermined voltage is applied, and are oriented aslant when a voltage smaller than said predetermined voltage is applied, said color filter substrate having plural kinds

of color decomposition filters formed on a transparent support member for each of the regions, comprising:

a step of forming plural kinds of color decomposition filters on the transparent support member for each of the regions;

a step of forming a transparent electrode on said color decomposition filters; and

a step of forming a light-shielding film at any position on said transparent electrode.

148 (147). A process for producing a color filter substrate according to claim 147 (146), wherein said step for forming the light-shielding film comprises:

a step of applying a photosensitive resist onto said light-shielding film which includes said transparent electrode;

a step of etching said photosensitive resist after it has been developed by exposure to light through a predetermined pattern; and

a step of annealing said photosensitive resist that is left on said light-shielding film after the etching;

wherein said photosensitive resist left on said light-shielding film works as an insulating protrusion.

149 (148). A process for producing a color filter substrate according to claim 147 (146), further comprising:

a step of applying a positive-type photosensitive resist onto said transparent electrode which includes said light-shielding film after the step of forming said light-shielding film;

a step of developing said negative-type photosensitive resist after said negative-type photosensitive resist has been exposed to light through said light-shielding film; and

a step of annealing said photosensitive resist that is left on said light-shielding film after the developing;

wherein said photosensitive resist left on said light-shielding film works as an insulating protrusion.

add D1